REMARKS

Further and favorable reconsideration is respectfully requested in view of the foregoing amendments and following remarks.

Claim 1 has been amended to incorporate the limitations of claim 18, as a result of which claim 18 has been cancelled. Claims 2-5 have been cancelled and claims 11 and 12 have been amended as a result of the amendment to claim 1, to prevent redundancy of claim limitations. Claim 14 has been amended to replace the term "burnishing" with "deep rolling". As is discussed in detail below, the term "burnishing" is actually a poor translation of the French word "galetage". A good translation of this term is "deep rolling". Additionally, support for this amendment can be found on page 1, lines 18-29 of Applicants' specification.

The patentability of the present invention over the disclosures of the references relied upon by the Examiner in rejecting the claims will be apparent upon consideration of the following remarks.

Thus, the rejection of claims 1-18 under 35 U.S.C. § 103(a) as being unpatentable over Bellus et al. in view of Heffron et al. is respectfully traversed.

The Examiner takes the position that Bellus et al. disclose a method of fabricating a steel part for automotive components by subjecting metal blank to forging and cooling. The Examiner admits that Bellus et al. fail to include the additional step of mechanical reinforcing. However, the Examiner asserts that it would be an obvious step to incorporate since it is a standard conventional finishing step well known in the art when producing crankshafts for automobiles, as taught by Heffron et al.

Applicants previously argued that burnished, as discussed by Heffron et al., does not refer to a mechanical reinforcing operation, but rather a machining operation which aims at making the bearing surface as smooth as possible. Applicants' use of the term "burnishing" refers to a mechanical reinforcing performed with rolls which cause high compressive mechanical residual stresses and surface hardening. The Examiner asserts that the burnishing step of Heffron et al. is equivalent to the burnishing recited in Applicants' claim 14, since the techniques of using rollers on forging surface are the same.

Applicants respectfully disagree. Initially, Applicants assert that the misunderstanding of the term "burnishing" is the result of a poor translation of the French word "galetage". A good translation of the term "galetage" is "deep rolling", which means supplying a high pressure by wheels (rolls) on a high depth of the product (4-5 mm). This operation is well defined on page 1, lines 18-29 of Applicants' specification. The object of this operation is to obtain a strong strain-hardening of the metal. Furthermore, Applicants enclose herewith a document which shows that "machine a galeter" translates to "roller finishing and deep rolling machines". (Please see excerpt from EMO Hannover, attached hereto.) Therefore, "deep rolling" is a usual translation for "galetage".

On the contrary, "burnishing" refers to an operation, the aim of which is to obtain a smooth, polished surface by way of machining, which is performed with cutting tools. Heffron et al. teach that burnishing is performed in order to obtain the final bearing finish, that is a determined surface quality after a preliminary machining and grinding. (See column 1, lines 22-23 of Heffron et al.)

Burnishing (or machining), as taught by Heffron et al., and deep rolling, as recited by Applicants, cannot be performed with the same tools. A machining/burnishing step needs cutting tools, while deep rolling needs wheels/ rolls with smooth surfaces, without any cutting parts.

Furthermore, the parts of the crankshaft treated in Heffron et al. and in the present invention are not the same. Heffron et al. teach burnishing the bearing surfaces. (See column 1, lines 20-22 of Heffron et al. On the contrary, in Applicants' invention it is primarily the fillets connecting the crank pins and the bearing which are deep rolled. (See page 6, lines 30-32 of Applicants' specification.) The bearings are not part of the crankshaft which undergoes particularly high stresses, while the fillets undergo high flexion strains which can lead to fatigue. (See page 4, line 33 to page 5, line 33 of Applicants' specification.) The question of a polished state of the crankshaft surface does not play any part in this mechanism. In fact, a polished state is not even desired on the deep-rolled fillets, since the building of cracks is involved by the deep rolling operation. Consequently, once it is understood that the translation of term "galetage" was poor, it is

clear that the teachings of Heffron et al. have nothing to do with Applicants' claimed invention. Therefore, Heffron et al. does not remedy the deficiencies of Bellus et al.

Additionally, Applicants previously argued that claim 18 (now incorporated into amended claim 1) was patentable over the cited references because neither of the cited references teaches or suggests a steel which contains 0.005 to 0.06% Nb, 0.005 to 0.04% Ti, where the Ti content is equal to at least 3.5 times the N content, and 5 to 50 ppm B. The Examiner asserts that Bellus et al. disclose steel examples having a composition which meets the recited claims. The Examiner further asserts that Bellus et al. do not teach N as an alloying constituent, and therefore N would be present at an inevitable impurity level kept as low as possible since it would be an undesirable element. The Examiner further states that having Ti amounts equal to at least 3.5 times the N content would be expected by the prior art alloy, because it contains a high Ti content of 0.005 to 0.03%, and a low impurity N level.

However, if Ti = 0.023%, as in the examples of Bellus et al., then N would have to be less than 0.0065% in order to possess the required ratio as recited in Applicants' claims. Such an N content is not particular low, and it is very easy to unintentionally obtain much high contents of N. This is particularly true when the steel is obtained from melted scraps in an electric furnace, as is most often the case for steels, which will be forged later, as in the invention and in Bellus et al.

Additionally, the Examiner has completely neglected the fact that Bellus et al. and Applicants' invention have completely different requirements on the thermomechanical treatments undergone by their steels, which lead to different metallurgical structures. Consequently, (1) the parts obtained by Bellus et al. have mechanical properties which do not make them particularly fit for making crankshafts, and (2) performing a deep rolling on these parts, which can have up to 20% ferrite in their structure, would not allow the benefit of the advantages of Applicants' invention; on the contrary, such a structure is detrimental when it is deep rolled.

Bellus et al. (which has the same owner as the present application) needs very particular thermal treatments, since the cooling between 600 and 300°C needs a long stay at precise temperatures within this range.

On the contrary, Applicants' invention requires a continuous cooling within this range, either in still air or by blowing air onto the crankshaft, according to its dimensions, in order to guarantee a cooling speed of $\leq 3°C/s$ between 600 and 300°C, which leads to a 100% bainite structure.

In Bellus et al., if bainite is formed, it is always lower bainite (due to the interruption of the cooling). At 700°C, Bellus et al. aim for a cooling speed of $> 0.5°C/s$, preferably $> 2°C/s$, down to a temperature T_m between $M_s + 100°C$ and $M_s - 20°C$. (See column 3, line 62 to column 4, line 11.) Tm lies between 600 and 300°C. There is no upper limit to the cooling speed in this interval. On the contrary, in Applicants' invention, there is an upper limit of 3°C/s but without any interruption, in order to obtain a bainitic structure, without martensite.

Further, the invention of Bellus et al. tolerates up to 20% ferrite. On the contrary, ferrite is not present in Applicants' steel. This exclusion comes from the desired effects of the combination of a 100% bainitic structure and of the deep rolling. The deep rolling operation is very detrimental, if performed on the ferrite, and can lead to a cracking of the steel. It can be seen in the present application that the reference example which contains ferrite (ferrito-pearlitic structure) has very poor fatigue results after deep rolling.

Additionally, trials were preformed on examples of a steel having a 100% bainitic structure, corresponding to the second implementation of the invention as described on page 11, lines 3-25 of Applicants' specification. The composition of this steel was C=0.299%; Mn=1.478; Si=1.160%; Ni=0.169%; Cr=0.870%; Mo=0.104%; V=0.114%; Cu=0.963%; Nb=0.052; B=30ppm; Ti=0,028%; N=70ppm, which gives Ti/N=4, so >3.5; S=0.024%; and Al=0.021%. After forgoing and cooling in still air at 0.5 to 1°C/s, as 100% bainitic structure was obtained and no further tempering or annealing was performed.

A remarkably high tensile strength of 1197 MPa was obtained, as well as a remarkably high yield strength of 766 MPa. These values are much higher than those for the reference steel described on page 12, lines 12-31 (860 MPA tensile strength and 570 MPa yield strength). After deep rolling the sample in the same conditions as for the reference steel, also with applied loads of 800-1200 daN, cracking started to occur for moments of 2150 to 2220 N.m, and rupture moments were 5600 to 5880 N.m. These are

significantly better values than for the reference steel. (See page 12, lines 26-31.) Specifically, the improvement for the cracking starting moment is 12% and 32% for the rupture moment.

For the above reasons, the invention of claims 1-18 are clearly patentable over Bellus et al. in view of Heffron et al.

Therefore, in view of the foregoing amendments and remarks, it is submitted that the ground of rejection set forth by the Examiner has been overcome, and that the application is in condition for allowance. Such allowance is solicited.

Respectfully submitted,

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EMO

Hannover

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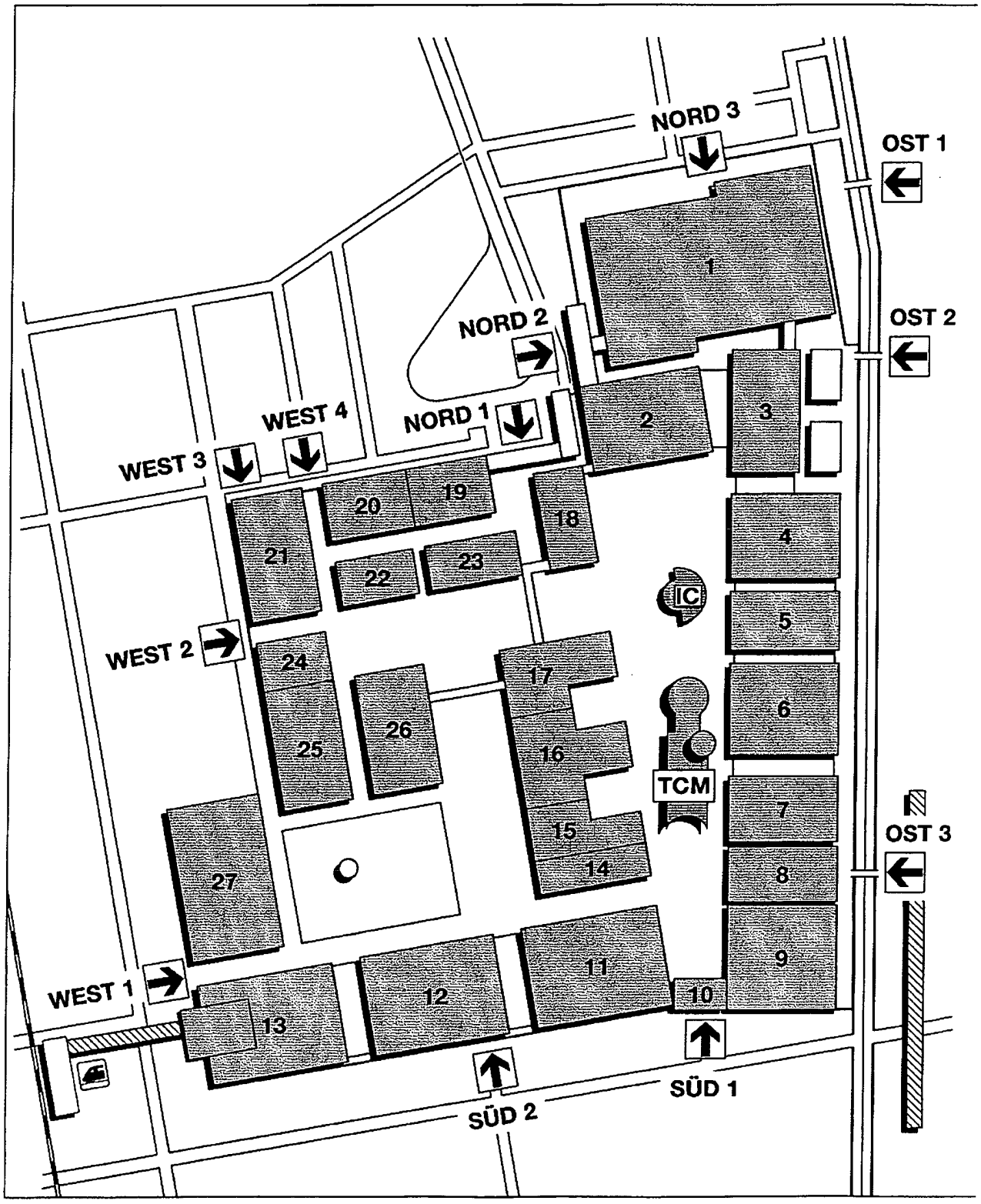

Änderungen vorbehalten · Subject to alteration
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